

## **EXHIBIT 1**

“Broadband Backgrounder: Public Policy Issues Raised By Broadband Technology”

by  
The Broadband Access Project  
of the  
Center for Democracy & Technology

# **BROADBAND BACKGROUNDER: PUBLIC POLICY ISSUES RAISED BY BROADBAND TECHNOLOGY**

Issued by the  
Broadband Access Project  
of the  
Center for Democracy & Technology

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## **The Center for Democracy and Technology and the Broadband Access Project**

The Center for Democracy and Technology (“CDT”) is dedicated to ensuring that democratic values and constitutional liberties are a central feature of the new digital age. With its unique mix of expertise in law, technology and public policy, CDT works for practical, real-world solutions that enhance free expression, privacy, open access and democracy in the rapidly evolving global communications technologies. CDT endeavors to build consensus among all parties interested in the future of the Internet, finding common ground among activists, nonprofit groups, Internet businesses and government policymakers.

Following the passage of the Communications Decency Act in 1996, CDT helped to organize the Citizens Internet Empowerment Coalition. Through the CIEC, leading members of the Internet industry challenged CDA’s constitutionality in *American Library Association/ACLU v. Reno*. When the case was argued in Philadelphia, the coalition brought the Internet into the courtroom through high-speed data lines. And when the case came before the Supreme Court, it was argued by the coalition’s counsel.

With its Broadband Access Project, CDT seeks to ensure that the characteristics of the narrowband Internet that were so critical in *Reno*, and the legal principles that came out of that case, continue to thrive as the Internet moves into the broadband world. The Project has looked at all forms of broadband access that are emerging as ways to reach the Internet, including cable modems, digital subscriber lines, satellites, and terrestrial wireless services. CDT has worked closely with a broad cross-section of the Internet, computer, and communications industries, as well as with consumer groups and other interested parties. It has developed a comprehensive and balanced assessment of where the technology is today, where it can be tomorrow, and what impact the new technology will have on speech and access to content on the Internet.

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# **BROADBAND BACKGROUNDER: PUBLIC POLICY ISSUES RAISED BY BROADBAND TECHNOLOGY**

Issued by the Broadband Access Project  
of the Center for Democracy & Technology

## **EXECUTIVE SUMMARY**

The extraordinary growth and innovation of the Internet, its ability to empower individuals, and its role in promoting free expression and democratic values depend critically on openness principles that have characterized the “narrowband” world of dial-up access. Some of these principles relate to the openness of the Internet’s standards and software. Some are engineering principles, designed to make the Internet function flexibly and efficiently. Others are policy choices regarding the telephone system, made before the Internet existed. These architectural elements and policy choices have implemented values as well as enabled communication.

The openness of the narrowband Internet has been responsible for the most democratic and dynamic form of mass communications ever created. As expressed by Judge Dalzell in *ACLU v. Reno*, “the Internet is a far more speech-enhancing medium than print, the village green, or the mails.” The Internet allows anyone to reach the entire world simply and inexpensively. It enables the unprecedented ability of speakers to speak and allows listeners to receive content, free from governmental or private interference.

Preserving openness and the dynamic nature of the Internet is critical to maintaining the democratic character of this medium as the Internet is transformed from the narrowband technologies of dial-up modems and slow content delivery to the “broadband” world of cable modems, DSL, wireless, and other technologies that deliver high-speed Internet access. Emerging broadband Internet technologies offer advantages over narrowband access that will enhance and expand the Internet’s usefulness to users. Broadband Internet will allow subscribers to send or receive video and audio content of digital quality and to download interactive, graphic-rich webpages. The high-speed technology will enable entrepreneurs to bring new services to market that will make the Internet interactive in real time.

However, critical differences between the narrowband and broadband Internet could change the open nature of the Internet and raise the possibility that this dynamic and democratic medium might come to be dominated and in part controlled by a small number of private

companies. Until now, this open quality has allowed Internet users a wide range of choices about how to access the Internet and what to do with the communications medium once online. As the Internet evolves from narrowband technologies to broadband, it is imperative to maintain openness and the empowering and democratizing characteristics of the Internet that flow from that openness. Policymakers face the momentous challenge of ensuring that the empowering aspects of the Internet of the past ten years are carried over into the Internet of the new century.

The Center for Democracy and Technology is committed to preserving the open character of the Internet. From the outset, CDT helped define the vision of the Internet as a uniquely user-controlled, decentralized, democratic medium. CDT was at the forefront of the legal challenges to the Communications Decency Act and framed the legal strategy that culminated in the Supreme Court's landmark decision in *Reno v. ACLU* extending to Internet speech the highest level of constitutional protection. Since then, CDT has been instrumental in educating policymakers about the empowering potential of an open, accessible Internet.

CDT believes that it is imperative to ensure that the open and democratic characteristics of the narrowband Internet central to the *Reno* decision are carried over into the emerging broadband Internet. To evaluate the potential impact of the evolution from narrowband to broadband, CDT undertook its Broadband Access Project, an objective assessment of the factual and public policy issues raised by emerging broadband delivery technologies.

This paper explains what the broadband openness debate is about, and describes the major broadband delivery technologies, focusing on cable modem access. It finds that openness is feasible and critically necessary across a broad range of technologies to preserving the free speech and democracy enhancing character of the Internet. It provides a factual primer and considered analysis of the issues, while it leaves to policymakers and public debate the questions of what constitutes openness, and how best to achieve it.

### **The Narrowband Internet**

The beginnings of narrowband Internet are well known, but it is worth recalling their implications for the transition to broadband. Narrowband Internet had its origins in ARPANET, an early data communications network developed in the late 1960s under the auspices of the government's Defense Advanced Research Projects Agency ("DARPA"). A number of different individual networks of linked computers developed in the 1970s, typically to serve specific segments of the academic or governmental communities. The National Science Foundation ("NSF") spearheaded an effort in the 1980s to link these networks using common protocols. NSF, while it financed the initial Internet "backbone" carrying communications between the linked government and academic networks also through its policies encouraged the development of private competitive backbone networks. The usefulness of these networks depended upon the ability of individual users to access them via the "last mile" of the telephone line via modem.

It is accepted wisdom that the Internet has prospered because it has not been regulated. On many levels this wisdom is true, except it is also true that the Internet prospered *because* the Federal Communications Commission (“FCC”) *imposed* significant regulation on the facilities over which most people access the narrowband Internet – the telephone system. The successful shift of the narrowband Internet from a publicly funded effort to a private sector, commercial effort providing services to individual users through the telephone network depended on critical non-regulatory *and regulatory* decisions by the FCC – in some cases to regulate, in others not to:

- ✎ The FCC’s 1968 *Carterfone* decision struck down a prohibition against customer connecting their own telephone equipment to AT&T’s network. Rejecting claims by AT&T that third party equipment and services would harm the network, the FCC determined that customers could connect their own equipment to the network, so long as the equipment did not in fact harm the functioning of the network. The *Carterfone* decision opened the door to the development and improvement of a piece of equipment vital to today’s Internet – the modem used to transmit data signals over ordinary telephone lines.
- 6. The FCC made a further decision to regulate in its *First Computer Inquiry* in 1970. In that decision, the FCC forced facility-owning companies to (a) segregate their data businesses and (b) provide vital telephone services to data service competitors without favoritism or discrimination.
- 7. In that same decision, however, the FCC decided *not* to regulate data service companies. Thus, the FCC laid the groundwork for the explosion of thousands of ISPs competing to offer better, faster, cheaper Internet service.

Taken together, the *First Computer Inquiry* and *Carterfone* decisions were significant and affirmative regulatory steps that permitted the creation and ultimate explosion of the Internet.

### **Rollout of Broadband Technologies**

Technologies supporting high-speed transmission of data have been available for years, but only at a substantial price. Widely affordable broadband services are currently emerging, along with a mass interest in and market for those services. The new market for broadband services is an outgrowth of technological improvements, increased competition, and increased acceptance of and interest in the Internet.

At its simplest, broadband allows higher speed transmission of data. But it also makes it possible for the user’s Internet connection to be “always on” – in other words, the Internet can always be available, allowing users to seek information from the Internet far more often than with dial-up access. Broadband also allows users access to much more video and other high bandwidth content than would be possible over a narrowband connection.

These capabilities give users a far wider range of potential uses for the Internet. Professionally, users will be able to telecommute and establish home offices by enabling access to corporate networks, e-mail systems, and videoconferencing. Broadband will facilitate the creation of home-based businesses through web serving, e-commerce with customers and financial functions. Broadband Internet will allow a wider range of entertainment activities, including web surfing at higher speeds with richer video content, video on demand, and interactive, multi-player video games. Consumers will be able to shop, access telemedicine, participate in distance learning, take advantage of public services, research information and videoconference with friends and family.

### **Technologies for Broadband**

There are a variety of different and competing technologies that promise to deliver broadband Internet access to both individual and business users. The leading technologies are Digital Subscriber Line (“DSL”) service and “cable modem” service, with wireless, satellite and other technologies still emerging.

**Cable:** In the mid-1990s, the cable industry undertook the massive and expensive conversion of its traditional cable facilities into systems that (a) could support two-way transmission of signals, and (b) had a much higher capacity to support analog video signals, digital video signals, and data signals. As of August 1999, over one million homes in North America subscribe to cable modem service, 300,000 of which are in Canada. Cable systems pass approximately 90% of the homes in the US. The leading US cable operators forecast that 90% of their systems will have been upgraded by the end of the year 2000, and forecasts suggest that by 2001, cable modem service will be an option for as many as 80 million homes in the United States.

**Digital Subscriber Line – DSL:** Digital Subscriber Line (“DSL”) uses existing copper wires to provide high speed data services. The technology was developed in the late 1980s and was first widely used for non-Internet specific applications. With asynchronous DSL (“ADSL”), a high-speed data connection can be run over the same wire that is used to carry a regular phone line. Thus, ADSL can share an existing wire with a user’s existing voice telephone line, permitting both DSL and telephone services to be used at the same time. ADSL service operates on dedicated wires that are unaffected by high usage by neighbors. Theoretically, ADSL service will provide more reliable, but somewhat slower Internet access than cable modem service. There are two primary types of DSL providers: Incumbent local exchange carriers (“ILECs”) such as Verizon and Bell South (historically the primary local telephone companies in their regions), and competitive local exchange carriers (“CLECs”), such as Covad. At the end of 1999, an estimated 500,000 DSL lines were deployed in the United States, with about 75% being ILEC lines and 25% being CLEC lines. Deployment has exploded in the year 2000, and significant growth is expected in later years.

**Other Technologies:** Broadband will also be available over terrestrial wireless and other technologies. Although significantly less established and deployed than cable and DSL broadband services, terrestrial wireless services using land-based transmitters can also provide broadband services to businesses and individuals. While a number of different technological approaches will be available, it is not clear which will be successful in the marketplace. Nevertheless, it is likely that for some categories of users, broadband wireless will compete with cable and DSL services to provide broadband access to the Internet.

Beyond cable, DSL, and terrestrial wireless services, other broadband access methods are still in development or testing. Satellite access technology will use satellites to deliver Internet access to homes and businesses. Fiber optic lines running directly into users homes and businesses – often referred to as “fiber-to-the-home” – will deliver broadband. Although fiber does not share the same technological uncertainties facing satellite systems, it is not clear whether it will be economically viable to run fiber optic wires through existing residential neighborhoods. Finally, a number of schemes to use power lines to transport Internet access services have been explored over the past few years, but none of the yielded marketable service offering. If powerline based services are successfully developed, utility companies could become players in the broadband access market.

### **An Overview of the Policy Debate**

The most significant policy questions have involved the cable industry and efforts by ISPs and others to offer services over cable systems. Other questions relate to the provision of DSL services, while other issues are more general in focus. Resolution of the cable or DSL specific issues could have direct implications in other technology areas. For example, how policymakers resolve the “access to cable” issues could affect the development and deployment of wireless technology. These decisions should be made with a broad perspective of the Internet.

**Cable-Specific Issues:** The key broadband issues that specifically relate to Internet access over cable systems are rooted in the broad policy question of whether cable-based Internet access should be treated similar to cable television service (which has been largely unregulated) or similar to telephone service (which has been subject to significant regulation). Some cable companies have argued that additional regulations should not be imposed on the cable industry, even if it is providing Internet access. On the other hand, proponents of “open access” have argued that the regulations applicable to the telephone system has been vital to the growth of the Internet, and similar regulations should be imposed on Internet access over cable. Finally, some local telephone service providers have argued that the incongruity in the levels of regulation for the telephone and cable industries should be resolved by reducing regulations applicable to telephone service, rather than by imposing regulation on cable-based Internet service.

**DSL-Specific Issues:** The broadband issues relating to Internet access over digital subscriber line (“DSL”) systems generally involve the ability of competitive local exchange

carriers (“CLECs”) to compete with incumbent local exchange carriers (“ILECs”). Under the Telecommunications Act of 1996, ILECs are required to make certain pieces, or “elements” of their network available to CLECs to enable CLECs to compete with the ILECs in the provision of local phone service and Internet access service. The policy questions center around whether the ILECs are fully complying with their statutory and regulatory obligations to act properly toward, and compete fairly with, the CLECs. Most of the DSL specific issues reflect CLEC challenges to ILEC actions, and are already the subject of legal or regulatory proceedings at the state and/or federal levels. As a general matter, the CLECs do not seek major changes in laws or regulation, but instead seek stronger and faster enforcement of existing regulations and statutes.

**The Emerging Broadband Content Distribution Model:** A vitally important result of the Internet’s infrastructure is that any speaker on the Internet can reach any listener. On the Internet, a single speaker and the largest media company have roughly the same abilities to speak and be heard. There is significant risk on a broadband Internet, where locally-based broadband content servers deliver broadband content quickly to consumers, the major means of broadband distribution will be the proprietary domains of large companies or wealth speakers, ending the rough equality among speakers so critical to the Internet’s promotion and facilitation of democracy.

### **A Focus on the Cable “Third Party Access” Debate**

Far and away the most contested issue relating to broadband access to the Internet is the “open access” or “forced access” issue – whether cable system operators must permit unaffiliated Internet Service Providers to offer Internet access services over the cable facility. As is done in Canada, where cable modem deployment and “open access” are both more advanced than in the United States, this paper uses the term “third party access” to refer to this policy issue.

Without drawing conclusions, the paper looks closely at the specific arguments and claims made in the third party access debate. Unlike the telephone system, cable has not been subject to regulation as a common carrier. The paper examines the decision not to regulate cable and its effect on the debate about imposing a third party access requirement on the cable industry. The paper probes the claims made by advocates of mandatory third party access, including the risk of censorship and concerns about anticompetitive behavior. It also discusses the claims made by opponents of mandatory third party access, including the incentives to upgrade the cable systems to support Internet access, the potential for a regulatory morass, and the constitutional rights of cable operators.

However, the paper does find that openness is feasible. It examines the technological issues surrounding feasibility, concerns raised by the shared nature of the cable network, and whether there is validity to the much debated (but no longer enforced) “10 minute” limit imposed on streaming video over cable systems. For each of these issues, the paper offers an informed and

balanced assessment of whether the claims and arguments are justified. It finds that, as demonstrated by the recent movement by leading U.S. cable companies to accept some form of voluntary open access, no one is strongly asserting that it is not possible. It further finds that, while concerns are inherent in the provision of Internet access over a cable system, many of these are present with or without third party access, and many will be resolved as engineers turn their attention to designing equipment that supports third party access in cable systems. As the debate has evolved, there is no longer any serious question about whether third party access is feasible or desirable – it is both. The main focus of the debate today is on how third party access will be implemented.

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## **INTRODUCTION**

Open and decentralized, the current “narrowband” Internet is the most democratic and dynamic form of mass communications ever created. The narrowband Internet operates without gatekeepers. It is not limited by scarce spectrum or dependent on other scarce resources. Anyone who wants to can be a publisher and can reach the entire world simply and inexpensively. Barriers to entry are low, and anyone who wants to can become an Internet Service Provider and a part of the global network on an equal par with others. The Internet’s broad availability gives business, non-profit organizations and individuals an unprecedented ability to speak, and allows listeners to receive information, free from governmental or private interference. The narrowband Internet is a medium that, as Judge Dalzell stated in his decision in *ACLU v. Reno*, “provides significant access to all who wish to speak in the medium, and even creates a relative parity among speakers.”<sup>12</sup>

Today, the Internet is on the threshold of a transformation from the narrowband technologies of dial-up modems and slow content delivery speeds to the broadband world of cable modems, DSL, wireless, and other technologies that deliver high-speed Internet access. Emerging broadband Internet technologies offer tremendous advantages over narrowband access that will enhance the Internet’s usefulness to users. But as the Internet shifts from a narrowband foundation to one based on broadband technologies, it is imperative that its openness, and the empowering and democratizing characteristics of the Internet that flow from that openness, are not lost.

The Center for Democracy and Technology is committed to preserving the open character of the Internet. From the outset, CDT helped define the vision of the Internet as a uniquely user-controlled, decentralized, democratic medium. CDT was at the forefront of the legal challenges to the Communications Decency Act and framed the legal strategy that culminated in the Supreme

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<sup>12</sup> *American Civil Liberties Union v. Reno*, 929 F. Supp. at 882.

Court's landmark decision in *Reno v. ACLU* extending to Internet speech the highest level of constitutional protection. Since then, CDT has been instrumental in educating policymakers about the empowering potential of an open, accessible Internet.

CDT believes that it is imperative to ensure that the open and democratic characteristics of the narrowband Internet central to the *Reno* decision are carried over into the emerging broadband Internet. To evaluate the potential impact of the evolution from narrowband to broadband, CDT undertook its Broadband Access Project to objectively assess the factual and public policy issues raised by emerging broadband delivery technologies.

CDT believes that critical differences between the narrowband and broadband could change the essential open nature of the Internet and raise the possibility that this open, dynamic and democratic medium might come to be dominated and in part controlled by a small number of private companies. Until now, the openness of the Internet has allowed users a wide range of choices about how to access the Internet and what to do once online. Policymakers must understand the impact of broadband technology on the Internet's openness, and should ensure that the empowering aspects of the Internet of the past ten years are carried over into the Internet of the next century.

The goal of this paper is to outline the basics of the broadband openness debate, to describe the major broadband delivery technologies, focusing on cable modem access, and thereby to provide policymakers and interested parties with considered analysis of the issues as they make decisions about what constitutes openness, and how best to achieve it. This paper finds that, to preserve the free-speech and democracy enhancing character of the Internet, openness is critically necessary across a broad range of Internet access technologies. It also finds, focusing on cable access, that it is technologically feasible to have openness. As the paper notes, the "open access" debate has shifted from whether there *can and will* be third party access to *how* such access will be implemented and monitored, and whether it should be mandated. As a result, while there are many challenging issues that remain to be resolved, the paper concludes both that openness is technically feasible and that implementing it is crucial to preserving the democratic essence of the Internet in the broadband world.<sup>13</sup>

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<sup>13</sup> The questions of what criteria determine openness and what mechanisms might assure that it is achieved are addressed in a separate document CDT is filing with the Federal Communications Commission in response to its September 28, 2000 Notice of Inquiry. See, *In the Matter of Inquiry Concerning High-Speed Access to the Internet Over Cable and Other Facilities*, GN Docket No. 00-185, Comments of the Center for Democracy and Technology, December 1, 2000.

## **I. THE EVOLUTION OF THE NARROWBAND INTERNET: DRIVING THE ECONOMY AND EMPOWERING DEMOCRACY**

To make decisions on the policy issues that arise from the emergence of broadband technologies, it is important to understand how the Internet developed, how the narrowband Internet works today, and how regulation affects the Internet.

### **A. Historical Development: From Government and Academia to Industry and Consumers**

The Internet originally grew out of the ARPANET, an early data communications network developed in the late 1960's under the auspices of the Defense Advanced Research Projects Agency ("DARPA").<sup>14</sup> Key to its creation was the development of open, freely available standard protocols that for the first time allowed computers to communicate with each other, and then allowed networks of linked computers to communicate similarly with other networks.

A number of different networks of linked computers developed in the 1970's, typically to serve specific segments of the academic or governmental communities. Initially, many of these networks did not communicate with each other. Through the efforts of the National Science Foundation ("NSF") in the 1980's, many of these networks were linked together using common protocols. This "network of networks" came to be known as the Internet.

In addition to spurring academic and governmental networks to "internetwork" with each other, the NSF also financed the initial Internet "backbone" – a national communications network that carried communications between the linked networks. In an effort to spread the cost and take advantage of economies of scale, the NSF encouraged local and regional networks to offer network access to commercial customers. However, commercial communications over the NSFNET backbone were not permitted. This policy of denying commercial users access to the backbone, as it was intended to do, prompted the development of private, competitive backbone networks such as PSI and UUNET.

In the late 1980's, the NSF determined that the Internet would evolve most efficiently and effectively if the network was privatized. NSF worked towards this goal until 1995, when it halted funding and operation of its NSFNET backbone and began to help regional networks

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<sup>14</sup> The history and development of the Internet is summarized in "A Brief History of the Internet," written by nine of the early architects of the network, Barry Leiner, Vinton Cerf, David Clark, Robert Kahn, Leonard Kleinrock, Daniel Lynch, Jon Postel, Larry Roberts, and Stephen Wolff. The article can be found at <<http://info.isoc.org/internet/history/brief.html>>.

purchase backbone connectivity from private networks. Private business and consumer oriented networks had evolved during the 1980's, and over time these networks linked to the Internet.

In the early 1990's, at the same time that the Internet was coalescing as a global network of primarily *private* networks, a researcher in Switzerland conceived of and developed the World Wide Web. At its core, the Web is a set of "hypertext" protocols that operate over the Internet. They provide an easy way both to publish and to access information over the Internet.<sup>15</sup> With the development and popularization of the Web, commercial consumer networks such as Prodigy, CompuServe, and America Online experienced explosive growth, and the social and commercial phenomenon that is the Internet began.

## **B. Technology Basics: An Overview of the Internet Infrastructure**

Critical foundations for the Internet are communications protocols named "Transfer Control Protocol" and "Internet Protocol," which together are known as "TCP/IP." These fundamental protocols allow millions of otherwise incompatible computers and computer networks to communicate. A key innovation offered by TCP/IP was its use of small, independent "packets" of data to transmit communications, thereby avoiding the inefficiencies of the prior "circuit switched" world of traditional communications networks.

Prior to the Internet, most electronic communications – including ordinary telephone calls – occurred in a "circuit switched" environment.<sup>16</sup> When a telephone call or other communication is initiated in a circuit switched environment, the network creates a dedicated electrical path (or "circuit") to carry the communication. A telephone call, for example, has exclusive use of its electrical circuit until the call terminates. This circuit approach allows for relatively simple devices (such as telephones) to communicate reliably. Because telephone calls do not involve the *continuous* transmission of information, however, the dedicated use of a circuit is extraordinarily inefficient. Even with computer-to-computer communications, computers seldom transmit information constantly, and thus the communications circuits are almost never fully utilized.

In contrast to this "circuit switched" approach, TCP/IP allows "packet switched" communications. With packet switching, every communication is broken up into small, finite pieces. These pieces are transmitted across a computer network that simultaneously carries packets from numerous other communications. As described by one of the inventors of the TCP/IP protocols, Vint Cerf,<sup>17</sup> TCP/IP packets can be thought of as individual electronic postcards, and the Internet as a superfast postcard delivery system. When a communication is sent over the Internet (an e-mail, for example), the TCP/IP protocol on the sending computer

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<sup>15</sup> A timeline detailing the initial development of the World Wide Web can be found at <http://www.w3.org/History.html>.

<sup>16</sup> Still today, the vast majority of voice telephone calls are circuit switched.

<sup>17</sup> See Vint Cerf, "How the Internet Really Works – A Modest Analogy," [http://www.wcom.com/about\\_the\\_company/cerf\\_up/prose/hownetworks.shtml](http://www.wcom.com/about_the_company/cerf_up/prose/hownetworks.shtml).

breaks the message into discrete packets, each of which individually carries “to” and “from” addresses. Thus, a short message may be broken up and written in five parts, on five different postcards. The packets are sent into the network, and the network itself decides how to route each packet to the destination. If along the way a packet encounters congestion in the network, it might be re-routed along a different path. Thus, the various packets in a communication may not travel over the same path, may not arrive at the same time, and may not arrive in the same order as they were sent. The TCP/IP protocols on the receiving computer reassemble the packets into the correct order and request that any missing packets be sent again.

This packet switching allows for the operation of a reasonably efficient and reliable network linking many computers. The network as a whole can carry far more communications simultaneously than would be possible if dedicated circuits were required each time a computer communicated with another computer. A downside, however, is that if usage exceeds the network's optimum capacity, all packets (and thus all communications) might slow down.

Leading Internet companies, including the major telecommunications companies AT&T, WorldCom, and Sprint, and more Internet-focused companies such as PSINet, now operate nationwide or worldwide backbone networks to carry TCP/IP packets. Thus, if an AT&T customer in San Francisco seeks to access the web site of an Atlanta company that also happens to be an AT&T customer, the San Francisco consumer's TCP/IP packets would be carried by AT&T to Atlanta, and the Atlanta company's packets would be sent back to San Francisco. If the Atlanta company happens to be a PSINet customer, however, then AT&T would pass the initial request to PSINet for delivery to Atlanta, and PSINet would pass the response back to AT&T for delivery to the AT&T customer. Dozens of overlapping Internet backbone networks criss-cross the country and the world. Those networks interconnect so that packets originating anywhere on the Internet can reach computers anywhere else on the Internet.

Beyond the major Internet “backbone providers” that operate the nationwide or global interconnected networks that make up the core of the Internet, thousands of “Internet Service Providers” (“ISPs”) provide Internet service directly to individuals and businesses. Although backbone providers typically also operate as ISPs to provide service directly to customers, many Internet users obtain their service from ISPs that do not operate a backbone. Alternatively, many users obtain service from an “Online Service Provider” (“OSP”) such as America Online, which operates as an ISP but also offers its own proprietary content and services (which are not made generally available to non-subscribers). The OSPs and ISPs themselves connect to one or more of the backbone providers (or perhaps to a larger ISP that in turn connects to a backbone provider). Thus, a TCP/IP packet might be carried first by the sender's ISP, then by that ISP's backbone provider, then by a second backbone provider, and finally by the recipient's ISP.

Retail level ISPs (and OSPs such as America Online) offer a wide variety of services and service plans to Internet users. Some offer bare-bones access to the Internet; others offer both Internet access and the option to post a “home page” on the World Wide Web. Still others offer specialized packages aimed at business users. The Internet service market is highly competitive,

and in fact some companies are offering free Internet service in return for the ability to transmit advertisements to users while they are online. Some ISPs offer specialized packages aimed at particular market niches. Some ISPs, for example, focus on the family market and offer filtered Internet access that excludes certain types of content available on the Internet, such as adult-oriented content. Other ISPs offer packages aimed at people who use the Internet for real-time chatting with other users.

Although many people have high speed connections to the Internet at their place of employment, most individuals and small businesses access the Internet by using a modem and ordinary telephone line to call a dial-up ISP or OSP.

### **C. Practical Applications: How People Use the Internet Today**

The three dominant uses for the Internet today are (a) “surfing” the World Wide Web to find entertainment, get information, or make purchases, (b) electronic mail, and (c) “chat” and other real time communications. This Paper assumes a basic familiarity with these three types of communications. On the World Wide Web, Internet users can get access to an enormous range of non-commercial and commercial sites providing information, entertainment, political speech, commercial offerings, and online services. Electronic mail, or e-mail, is most typically used for one-to-one communications not unlike a postal letter or postcard, while “chat” or “instant messaging” are technologies that permit immediate (usually typed) communications between people worldwide.

These applications do not *require* high-speed broadband technology, but Web surfing in particular is dramatically enhanced by fast access speeds. Broadband access to the World Wide Web offers a much more efficient and enjoyable experience, and can deliver far more audio and video content than would be efficient with a narrowband, dial-up connection. Chat over broadband could eventually support two-way “video phone” images, and e-mail over broadband would likely make the sending and receiving of large audio or video messages more reasonable and more common.

### **D. Revolutionary Impact: Empowering Individuals and Building Communities Worldwide**

From its origins as an academic communications and resource-sharing tool, the Internet has evolved into a unique and unprecedented medium of mass communications that empowers individuals and businesses to reach millions of listeners worldwide. No other form of communications in our history has allowed speakers to reach the entire world, and to do so relatively simply and inexpensively. Moreover, no other means of communication has emerged as a mass medium so quickly, or evolved at the rate of change seen with the Internet over the past decade. The World Wide Web did not exist ten years ago, but is now a critical method of

communications for individuals and businesses trying to reach listeners and consumers. While few were even aware of the Internet five years ago, today it is a primary communications tool for tens of millions of people.

One key to its growth and success is that the Internet is widely available and relatively free of restrictions and rules that might limit its growth or the growth of new communications tools that use the Internet. Individuals and businesses are free to innovate and push the capabilities of the communications medium, and individual listeners are free to experiment with, and embrace, the new innovations.

The explosive growth and evolution of the Internet has prompted a revolution in business. Small and large businesses can reach new markets. Entrepreneurs can implement new business models rapidly and test new products without enormous up-front costs. And startup companies can become major e-commerce players almost overnight.

As one federal judge noted in a very early legal decision affecting the Internet, some important characteristics set it apart from other communications medium:

Four related characteristics of Internet communication have a transcendent importance to [the court's deferential analysis of the Internet]. . . . First, the Internet presents very low barriers to entry. Second, these barriers to entry are identical for both speakers and listeners. Third, as a result of these low barriers, astoundingly diverse content is available on the Internet. Fourth, the Internet provides significant access to all who wish to speak in the medium, and even creates a relative parity among speakers.<sup>18</sup>

Because of these characteristics, that judge indicated that “[i]t is no exaggeration to conclude that the Internet has achieved, and continues to achieve, the most participatory marketplace of mass speech that this country – and indeed the world – has yet seen.”<sup>19</sup> In determining that the Internet’s content deserved a very high level of constitutional protection, the United States Supreme Court recognized the Internet’s unprecedented reach:

From the publishers' point of view, it constitutes a vast platform from which to address and hear from a worldwide audience of millions of readers, viewers, researchers, and buyers. Any person or organization with a computer connected to the Internet can “publish” information. Publishers include government agencies, educational institutions, commercial entities, advocacy groups, and individuals.<sup>20</sup>

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<sup>18</sup> *American Civil Liberties Union v. Reno*, 929 F. Supp. 824, 877 (E.D. Pa. 1996) (Dalzell concurring) (hereafter *Reno* District Court Opinion”), <<http://www.ciec.org/victory.shtml>>.

<sup>19</sup> *Id.* at 881 (Dalzell concurring).

<sup>20</sup> *Reno v. American Civil Liberties Union*, 521 U.S. 844, 853 (1997), <[http://www.ciec.org/SC\\_appeal/decision.shtml](http://www.ciec.org/SC_appeal/decision.shtml)>.

The empowering and democratizing aspects of the Internet are direct – though perhaps neither fully anticipated nor intended – consequences of the Internet's open, and decentralized architecture. The open ability for speakers and listeners to gain access to the Internet, and the decentralized and uncontrolled nature of speech over the Internet, have been essential to realizing the Internet's promise to promote free expression, spur economic growth, create new forms of community online, and reinvigorate democracy.

Emerging broadband technologies could change the essential open nature of the Internet. One of the challenges facing policymakers today is the need to anticipate the possible impact of broadband technology on the Internet, and to ensure that the empowering aspects of the Internet seen in the past ten years can be carried over into the Internet of the twenty-first century.

#### **E. Empowering Characteristics of the Narrowband Internet**

To assess the potential impact of broadband technology on the nature of the Internet, it is helpful to identify the characteristics of today's Internet that promote user empowerment, democracy, technological innovation, and broad deployment of Internet access. A wide range of discrete characteristics of the narrowband Internet have combined to create an extraordinarily open and dynamic communications medium, and have fostered the environment of democratic expression and technological innovation that is the hallmark of the narrowband Internet. These vital characteristics can be roughly divided into three groupings:

##### **Freedom to listen, speak, and be heard:**

- Internet users have essentially unrestricted access to speech of others. Any user can access any publicly posted constitutionally protected speech on the Internet free from significant interference or restrictions imposed by their ISP, the communications facility owner (i.e., the telephone company) connecting them to their ISP, or the government.
- Internet users have a variety of simple, inexpensive, and effective ways to speak and be heard. Internet speakers can post essentially any constitutionally protected speech free from interference or restrictions imposed by their ISP, the communications facility owner, or the government and can do so for relatively little expenditure.
- There is a rough equality among speakers, with no particular group of speakers being significantly favored over other groups. All speakers can reach all Internet users essentially equally. Although corporate or wealthy individual speakers might be able to speak simultaneously to more people than can a small speaker, a small speaker can nevertheless maintain (at

relatively low cost) a World Wide Web site that can reach users around the world, and can do so with roughly the same quality of delivery as is available to corporate or wealthy speakers.

**Freedom to innovate and experiment:**

- Internet users are essentially unrestricted in their ability to use the Internet. They are generally free to use their Internet connections to access any part of the Internet and to run any Internet-related application, so long as such use does not harm the operations of the network or the use of the Internet by others.
- Internet users can experiment with new communications methods and applications, and can do so without requiring permission from their ISP or facility owner. Conversely, technology innovators and entrepreneurs can reach potential users and customers, who can in turn experiment with a newly developed technology.

**Freedom to choose from among numerous Internet Service Providers:**

- In most places in the United States, Internet users have a wide range of choices among ISPs offering access to the Internet. These choices usually range from “bare bones” access to the Internet to friendly, handholding service providers to ISPs that focus on particular niche markets.
- By the same token, ISPs are able to operate under a wide variety of business models and offer a wide variety of services to users.
- Users can reach ISPs, and ISPs can reach users, without any significant restrictions imposed by the communications facility owner (i.e., the telephone company) connecting users to their ISP. The facility owner cannot discriminate against or in favor of any particular ISP or type of ISP.
- It is relatively easy and inexpensive to become an ISP and begin to offer narrowband services. The number of ISPs within a given market is not limited by technology or any other artificial constraint, and is limited only by what the market can bear.

Whether or not each one of these characteristics of the narrowband Internet is essential, standing alone, it is clear that taken together, these characteristics enable the Internet to be the dynamic and open medium it is.

## **F. Regulatory Framework of the Narrowband Internet: Simultaneously Regulated and Unregulated**

As long as there have been national political debates and controversies about the Internet, many policymakers and debate participants have asserted that the Internet is not regulated. Advocates both in the United States and around the world have argued against regulation of the Internet, contending that the Internet has not been regulated in the past, and that governments should not start now.

The assertion that the Internet is not regulated is certainly true, *but only in part*. The fact that most technological and structural aspects of the Internet have not been regulated has been vital to its explosive growth. On the other hand, the vast majority of the users of the Internet access the Internet every day using a system that historically has been highly regulated – the telephone system. Just as the growth of the Internet depended on a lack of regulation in many areas, the growth of the Internet *also* depended on the regulation of the telephone system. Indeed, one of the most critical developments that permitted the Internet to come into existence – the right of businesses and consumers to use modems over telephone lines – was the *imposition* of a regulatory burden on the owners of the telephone network.

In reality, as detailed below, regulation has played a vital role in encouraging and permitting the Internet to develop, and a full understanding of that role is important for any policymaker confronting issues relating to broadband access to the Internet. But because affirmative regulation of the means of access has been vital to the growth of the Internet does not necessarily mean that regulation is the answer to any current or future policy questions. Regulation unquestionably imposes significant costs, and the potential benefits of regulation must always be weighed against its costs.

It is difficult to construct a scheme of categories that effectively separates the aspects of the Internet that have not been regulated from those aspects that have. A “content-versus-facilities” distinction fails because although Internet content has generally not been regulated, neither have important parts of the physical facilities that make up the Internet. A distinction based on physical location within the network is flawed because unregulated elements of the Internet can be connected using regulated elements of the telephone system. The most successful distinction is one between “old” or traditional multi-purpose infrastructure and modes of communications on the one hand, and “new” Internet-specific infrastructure and modes of communication on the other hand. The following sections briefly trace the history of regulation affecting the Internet, and discuss in greater detail the distinction between multi-purpose and Internet-specific infrastructure.

# *1. A History of Simultaneous Regulation and Unregulation of What Ultimately Became the Internet*

According to FCC Chairman William Kennard, “[f]or the past 30 years, the FCC has created a deregulatory environment in which the Internet could flourish.”<sup>21</sup> Similarly, upon the release of an analysis of FCC’s regulatory interaction with the Internet, the FCC emphasized that the “Internet Prospers with ‘Hands-Off Unregulation.’”<sup>22</sup> While these claims are justified – the FCC certainly contributed to the Internet by allowing it to evolve without interference – they gloss over an important part of the story. Even as the FCC took steps to *deregulate* or avoid regulation of the advanced data services that led to the Internet, it was taking affirmative *regulatory* steps that allowed those data services to flourish and to protect Internet users’ competitive and flexible access to the Internet.

In 1966, the FCC initiated a regulatory inquiry that would set the stage for the later evolution and dynamic expansion of the Internet. Responding to the then emerging reality that computer technology would increasingly be used to communicate and transmit data over ordinary telephone lines, the FCC proactively raised the questions of whether those data services should be regulated, and whether and how the owners of the underlying telephone facilities should be permitted to compete in the data services market.<sup>23</sup> The decisions reached in what is now called its *First Computer Inquiry* proceeding would have a dramatic impact on whether the Internet would be burdened with regulation.

The first question that the FCC addressed was whether computer data service companies should be subject to common carrier regulations in the same way that the telephone companies, on whose telephone lines the data was communicated, were regulated. After concluding that there were no significant barriers to entry into the data services market, the FCC decided that data services should *not* be regulated as common carriers.<sup>24</sup> Fifteen years later, as the Internet was commercialized in late 1980’s and early 1990’s, Internet Service Providers benefited from the FCC’s decision to forego regulation of data services.

The second question that the FCC answered in its *First Computer Inquiry* proceeding was whether telephone companies (primarily meaning, at that time, the American Telephone & Telegraph company before its breakup into AT&T and seven “local exchange carriers”) should be

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<sup>21</sup> “The Unregulation of the Internet: Laying a Competitive Course for the Future,” Remarks by Chairman Kennard Before the Federal Communications Bar, Northern California Chapter, San Francisco, July 20, 1999, <<http://www.fcc.gov/Speeches/Kennard/spwek924.html>>.

<sup>22</sup> “Internet Prospers with ‘Hands-off Unregulation’; FCC Paper Rejects Need for Precipitous Action,” Press Release, Federal Communications Commission, July 19, 1999, <[http://www.fcc.gov/Bureaus/OPP/News\\_Releases/1999/nrop9004.html](http://www.fcc.gov/Bureaus/OPP/News_Releases/1999/nrop9004.html)>. The analysis was prepared by Jason Oxman, then of the FCC’s Office of Plans and Policy. “The FCC and the Unregulation of the Internet,” Working Paper #31, Jason Oxman, Counsel for Advanced Communications, Office of Plans and Policy, July 19, 1999, <[http://www.fcc.gov/Bureaus/OPP/working\\_papers/oppwp31.pdf](http://www.fcc.gov/Bureaus/OPP/working_papers/oppwp31.pdf)>.

<sup>23</sup> *In the Matter of Regulatory and Policy Problems Presented by the Interdependence of Computer and Communication Services and Facilities*, 7 FCC 2d 11 (1966) (“*First Computer Inquiry*”).

<sup>24</sup> *First Computer Inquiry*, Tentative Decision, 28 FCC 2d 291, at ¶ 20 (1970).

permitted to offer data services in competition with data service companies that did not own telephone facilities. The FCC was concerned that the telephone companies might discriminate against unaffiliated data service providers in the provision of the telephone service that was essential for data companies to reach their customers. The FCC first concluded that common carriers should be permitted to compete in the data services market, but that (a) they must offer data services through a separate affiliate, and (b) they may not discriminate in favor of their data services affiliates.<sup>25</sup>

Thus, in its *First Computer Inquiry*, the FCC laid the groundwork for the explosion of thousands of ISPs competing to offer better, faster, cheaper Internet service. The FCC made the deregulatory, or *unregulatory*, decision that data service companies (and thus ISPs) should not be regulated. The FCC then took the affirmatively *regulatory* step of forcing the facility-owning companies to (a) segregate their data businesses and (b) provide vital telephone services to their data service competitors without favoritism or discrimination.

At the same basic time that the FCC initiated its *First Computer Inquiry*, it also took another regulatory action that – much later – directly enabled the Internet to become the mass medium it is today. In 1968, the FCC issued its *Carterfone* decision. That decision struck down a tariff, levied by AT&T, prohibiting customers from connecting their own telephone equipment to AT&T's network.<sup>26</sup> Rejecting claims by AT&T that third party equipment and services would harm the network, the FCC determined that customers could connect their own equipment to the network – so long as the equipment did not in fact harm the functioning of the network. In the mid-1970's, the FCC adopted specific rules that defined for the first time the exact standards that third-party equipment had to meet if it was to be connected to the telephone network.<sup>27</sup> The *Carterfone* decision opened the door to the development and improvement of a piece of equipment vital to today's Internet – the modem used to transmit data signals over ordinary telephone lines.

Taken together, the *First Computer Inquiry* and *Carterfone* decisions of the 1960's were significant and affirmative regulatory steps that permitted the creation and ultimate explosion of the Internet. The net effect of those decisions was to require the facility owner to carry the data services of competing service providers at published, tariffed rates, without discrimination in favor of an affiliated data service provider. Although the FCC determined in those proceedings that the data services industry itself should *not* be regulated, the Commission took strong steps to ensure that the new industry would have reasonable and non-discriminatory access to the telecommunications facilities necessary to provide the data services. At the same time as the FCC set the emerging data industry free to compete and evolve, the FCC ensured that the incumbent facility owner could not stand in the way of that competition.

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<sup>25</sup> *First Computer Inquiry*, Final Decision and Order, 28 FCC 2d 267, at ¶¶ 11-12 (1971).

<sup>26</sup> *In the Matter of Use of the Carterfone Device in Message Toll Telephone Service*, 13 FCC 2d 420 (1968).

<sup>27</sup> 47 C.F.R. Part 68.

## 2. *The Current Regulatory Framework Affecting the Narrowband Internet*

In a follow-up proceeding to the *First Computer Inquiry*, the FCC created the regulatory categories of “basic” and “enhanced” services. Basic services are the ordinary telephone services subject to common carrier regulation, while enhanced services are data services (including Internet service) not subject to regulation.<sup>28</sup> The FCC expressly defined “enhanced services” to be data transmission and computer processing services that are offered *over* basic common carrier facilities. In other words, the FCC plainly recognized that the data services that it sought to promote and encourage through an “unregulatory” approach nevertheless directly relied on the existence and openness of the underlying common carrier facilities. If the “basic” services were not available on a reasonable and nondiscriminatory basis, the “enhanced” services would not have taken off as they did.

The “basic” and “enhanced” service terminology, however, does not fully encompass all aspects of Internet service and communications, and thus is not wholly satisfying as a framework with which to analyze the Internet.<sup>29</sup> Because so much of Internet service and communications is *not* regulated, it may be more productive simply to identify the basic elements of a typical communication over the Internet, along with the regulations that apply to each element.

The following are the essential steps that occur when a hypothetical user accesses a major national company's site on the World Wide Web:<sup>30</sup>

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<sup>28</sup> *In the Matter of Amendment of Section 64.702 of the Commission's Rules and Regulations (Second Computer Inquiry)*, 77 FCC 2d 384, 419 (1980).

<sup>29</sup> Moreover, the basic and enhanced terminology has essentially been supplanted by the “telecommunications” and “information services” categories used in the Telecommunications Act of 1996. *See* 47 U.S.C. § 153. The exact scope of those new terms has yet to be fully determined and litigated.

<sup>30</sup> If the user happens to use a national backbone provider as a local ISP, then steps 3-7 of the table might not occur.

	REGULATION	NO REGULATION
1. The user types a "URL" (or web address) into a web browser on a home computer		Other than standards for electrical emissions from the equipment, there are no significant regulations imposed on the user's choice of computer, modem, or software.
2. The user's computer initiates a local telephone call to the user's local ISP and transmits the web request to the ISP.	Common carrier regulation requiring reasonable and nondiscriminatory rates for the "last mile" connection to the user. Both the user and the ISP can obtain local phone service essentially on demand.	
3. The local ISP routes the web request within its internal network (if any).		No significant regulations.
4. Typically using a dedicated line leased from the incumbent local phone company, the local ISP transmits the web request to a regional ISP.	Common carrier regulation requiring reasonable and nondiscriminatory rates.	
5. The regional ISP routes the request within its internal network (if any).		No significant regulations.
6. Using a dedicated line leased from the incumbent local phone company or a competitive provider, the regional ISP transmits the web request to a national Internet backbone provider.	Common carrier regulation requiring reasonable and nondiscriminatory rates.	
7. The regional ISP's backbone provider routes the web across the its national backbone network.		No significant regulations.
8. The backbone provider routes the web request to the backbone provider of the requested company. The transfer occurs at a public or private "peering" point pursuant to contract.		No significant regulations.
9. Typically using a dedicated line leased from the incumbent local phone company or a competitive provider, the second backbone provider transmits the web request to the company's web server on company premises.	Common carrier regulation requiring reasonable and nondiscriminatory rates.	
10. The company's web server receives and responds to the web request (and transmits the requested web page back to the user using a similar sequence of steps).		No significant regulations, either on the methods of operating a web server, or on the content of the web pages served by the company.

As the above chart indicates, elements of communication that are specific to the Internet are not regulated, but elements that travel over the facilities of the incumbent local telephone company are. The ILEC must provide service to both the user and the user's ISP without discrimination.

The conclusion that the Internet has benefited from both regulation and a lack of regulation does not by itself suggest resolution of any policy issue. It does suggest, however, that policymakers should be aware that the history of regulation and the Internet is subtler than is often suggested by policy advocates on all sides when issues surrounding broadband technology are discussed.

## II. THE EMERGING BROADBAND TECHNOLOGIES

Technologies supporting high-speed transmission of data have been available for years, but generally only at a substantial price. Widely affordable broadband services are currently emerging, and emerging with them are mass interest in and market for those services. The new market for broadband services is an outgrowth of technological improvements, increased competition, and increased acceptance of and interest in the Internet. To assess the policy issues raised by broadband technologies requires a basic understanding of these technologies, a discussion of their evolution, and a look at their strengths and weaknesses. This section presents the basics of broadband as concisely as possible.<sup>31</sup>

### A. Overview and Background

#### *1. Basic Terminology of Data Transmission Speed*

Today, most home consumers and many business users access the Internet using a modem and ordinary telephone line. The maximum speed of such a connection is 56 kbps (or 56 kilobits per second, or 56 thousand bits per second). This is a relatively slow speed, and is often called a “narrowband” connection (although it is in fact dramatically faster than modems could connect only ten years ago). Because of physical limitations in modem technology and the copper wire over which most telephone lines run, there is little prospect that the speed of traditional modems will see further significant increase. In contrast, a common broadband speed is 1.5 Mbps (or 1.5 megabits per second, or 1.5 million bits per second), or about 30 times faster than the 56kbps speed of an ordinary dial-up modem.

Some of these terms warrant further definition. A “bit” is the smallest piece of information stored by a typical computer. The term is short for “binary digit,” which is a piece of information that can have only one of two possible states (e.g., 0 or 1, yes or no, on or off). Numerically, a bit is represented by either a zero or a one. A byte (pronounced “bite”) is typically made up of 8 bits, and can be encoded to represent a single alphabetic character. Thus, in a common implementation of data storage and transmission, a word that is five letters long would take up 5 bytes of storage (which is the same as 40 bits of storage).

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<sup>31</sup> For a good and concise overview of broadband basics, see “Broadband Today,” Staff Report by the Cable Services Bureau of the FCC, October 1999, <<http://www.fcc.gov/Bureaus/Cable/Reports/broadbandtoday.pdf>>. For an excellent and in depth – but still quite accessible – analysis of the broadband technologies and the broadband market, see Kim Maxwell, “Residential Broadband: An Insider's Guide to the Battle for the Last Mile,” John Wiley & Sons, 1999. Maxwell's book contains a thorough review of the potential and limitations of the technologies, and has provided the foundation for much of the discussion in this section.

The speed of modems is commonly measured in terms of “bits per second” (“bps”) – how many bits can be transmitted over a telephone wire every second. The earliest modems (from the early 1960's) could transmit at a maximum speed of 300 bps, the rough equivalent of 37 characters of simple text per second. Thus, at 300 bps, it might require a modem 80 seconds to transmit a single page of typed text. By 1980, common modem speed had risen to 2400 bps, cutting the time to transmit the page of text to 10 seconds.<sup>32</sup>

By the early 1990's, modem speed had risen enough that the common measurement was no longer “bits per second,” but instead was “kilobits per second” (“kbps”) representing one thousand bits per second. Common modem speed by 1993 was 28.8 kbps, which is the same as 28,800 bps. At that speed, the hypothetical page of text would take less than a second to transmit. The standard today has about doubled to 56 kbps, or 56,000 bps. At that rate, the page of text takes less than half a second to transmit.<sup>33</sup>

With the rise of advanced word processors and pictures on the World Wide Web, however, one is seldom transmitting only a single page of simple text. For example, a sample Microsoft Word document with 12 pages of double-spaced text may be about 50,000 bytes (or about 400,000 bits) of data. A large, high-quality photograph might have more than 1 million bytes (or more than 8 million bits). Transmitting such a file at 56,000 bps would take over two minutes.

Files of this size and even more demanding full motion video strain the capacity of a 56 kbps motion (and the patience of the computer user). Broadband technologies can speed things up dramatically. A common broadband speed is 1.5 megabits per second (or 1.5 million bits per second, or 1.5 Mbps). At that speed, the large photograph could be transmitted in less than five seconds, compared to more than two minutes over a conventional modem. With compression techniques that can reduce the size of an image file without too much loss of image quality, the photograph could be transmitted over a broadband connection in a second or two.

## *2. What is Broadband Access, and Why is it Better than Dial-up Narrowband Access to the Internet*

At its simplest, “broadband” is simply higher-speed transmission of data. There is not, however, a generally accepted level of speed that everyone agrees qualifies as “broadband.” The FCC has chosen a relatively low threshold speed of 200 kbps for a service to qualify as

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<sup>32</sup> In the early days of modems, modem speeds were often quantified in terms of a “baud rate.” A baud rate is a measure of how quickly a modem can transfer certain data “states.” At low speeds (2400 bps or lower), the baud rate and bps were usually the same (and were often used interchangeably). Modem technology evolved, however, so that more bits per second could be transmitted at a given baud rate, and a typical 9600 bps modem, for example, still operated at 2400 baud. For the sake of simplicity, “baud” should no longer be used to quantify modem speeds.

<sup>33</sup> As a general matter, because of limitations in the copper telephone wires, 56 kbps modems in use in homes can receive data at a rate of 56 kbps, but can only transmit data at 33 kbps.

“broadband.”<sup>34</sup> This speed is about four times faster than a 56 kbps modem, but significantly slower than some available broadband speeds that exceed 1 Mbps. The FCC selected this speed because it is fast enough “to change web pages as fast as one can flip through the pages of a book and to transmit full-motion video.”<sup>35</sup>

The FCC also decided that to be considered a “broadband” service, the service had to support 200 kbps *in both directions* – both “downstream” from the Internet to the user, and “upstream” from the user back to the Internet. Although a significant upstream capability can be useful, the 200 kbps threshold set by the FCC is probably higher than necessary for many users. Internet users who spend most of their time (a) surfing the World Wide Web, (b) “chatting” with other Internet users, or (c) sending e-mail, probably would not consistently need or utilize as much as 200 kbps in upstream bandwidth.

The two broadband technologies already available to consumers on a large scale fit the FCC’s definition of broadband. Cable modem service generally provides throughput speeds of at least 1.0 Mbps, sometimes exceeding 3 – 5 Mbps, and occasionally going as high as 10.0 Mbps, depending on conditions. DSL comes in a wide variety of flavors and speeds, but common DSL offerings include downstream speeds of 384 kbps, 640 kbps, 1.5 Mbps, and as much as 7.1 Mbps. However, certain DSL services now available do not provide 200 kbps bandwidth *upstream*, and thus are not considered full broadband by the FCC.

Faster transmission speed is one major advantage offered by broadband technologies. But equally important are broadband connections’ ability to be “always on” – in other words, the Internet can always be available (assuming a computer is left turned on). With a dial-up modem, a user would have to initiate each connection through the modem, a process that can easily take more than a minute. With broadband services, the Internet is always available.

The significance of broadband connections being “always on” cannot be underestimated. Many broadband users report that this characteristic is more important than the higher transmission speed. With constant access to the Internet, users seek information (such as directory assistance or an up-to-date weather forecast) from the Internet far more often than with dial-up access.<sup>36</sup>

As the broadband market develops, the concept of “broadband” service will go well beyond simply the faster, always-on Internet connection. Companies that specialize in broadband access (such as @Home, which provides broadband service over cable systems around the country) are developing and offering access to much more video and other high bandwidth

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<sup>34</sup> *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps To Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996*, CC Docket No. 98-146, Report, 14 FCC Rcd. 2398, 2406 (1999).

<sup>35</sup> *Id.*

<sup>36</sup> “‘Always-on’ will drive broadband,” ZDNet News, Mar. 8, 1999, available at <<http://www.zdnet.com/zdnn/stories/news/0,4586,2222039,00.html>>.

content than would be possible over a narrowband connection. Thus, from the consumers' perspective, "broadband" will likely come to mean both high-speed, always-on access, but also content tailored to take advantage of the high-speed capabilities.

### 3. *Broadband Applications: How People Will (and Will Not) Use the Internet Tomorrow*

In his excellent book-length analysis of the emerging broadband marketplace, modem pioneer Kim Maxwell grouped potential *residential* broadband applications into three general categories: "professional" (activities related to users' employment), "entertainment" (from game playing to movie watching), and "consumer" (all other non-employment and non-entertainment activities).<sup>37</sup> With some modifications, Maxwell groups the activities as follows:<sup>38</sup>

#### Professional Activities:

- telecommuting (access to corporate networks and systems to support working at home on a regular basis)
- video conferencing (one-to-one or multi-person video telephone calls)
- home-based business (including web serving, e-commerce with customers, and other financial functions)
- home office (access to corporate networks and e-mail to supplement work at a primary office location)

#### Entertainment Activities:

- Web surfing (as today, but at higher speeds with more video content)
- video-on-demand (movies and rerun or delayed television shows)
- video games (interactive multi-player games)

#### Consumer Activities:

- shopping (as today, but at higher speeds with more video content)
- telemedicine (including remote doctor visits and remote medical analyses by medical specialists)
- distance learning (including live and pre-recorded educational presentations)

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<sup>37</sup> Kim Maxwell, "Residential Broadband: An Insider's Guide to the Battle for the Last Mile," John Wiley & Sons, 1999.

<sup>38</sup> Maxwell closely considers each potential application in terms of its potential to contributing to the cost of implementing broadband services. He concludes that in the near term few of the applications outside of the professional area will generate enough income to pay for broadband deployment. Any public policy efforts to finance broadband deployment should carefully consider Maxwell's assessments.

- public services (including voting and electronic town hall meetings)
- information gathering (using the Web for non-entertainment purposes)
- photography (editing, distributing, and displaying of digital photographs)
- video conferencing among friends and family

These applications have different bandwidth requirements, and some of them are still out of reach today. For example, all of the “professional” activities will likely be supported with less than 1.0 Mbps of bandwidth. Similarly, web surfing and home shopping will be supported with less than 1.0 Mbps of bandwidth.<sup>39</sup>

Movies and video, however, demand more bandwidth. Feature length movies can probably be delivered with 1.5 Mbps of bandwidth, but broadcast quality video will probably require *more*— perhaps as much as 6.0 Mbps.<sup>40</sup> Moreover, if high definition television (“HDTV”) is widely accepted as a new broadcast standard, that quality of video would require almost 20.0 Mbps of bandwidth – much higher than the current broadband technologies will support. Thus, although the technology is moving toward flexible, high-quality video-on-demand, the necessary speed is probably still more than a few years away from becoming a reality.

## **B. Broadband Over Cable**

Modern cable television systems had their origin in “community antennae television” (“CATV”) systems that served remote communities that could not receive distant broadcast signals. The CATV systems used a large satellite dish to receive television signals, and then distributed the signals to the community using coaxial (or “coax”) cables. Cable systems were capable of delivering many more channels than were commonly broadcast even in major cities, and cable soon spread to areas that could receive broadcast signals. Original cable systems had capacity for perhaps 50 channels of analog video, and only supported one-way (downstream) transmission of video signals. Between the cable “headend” (typically where satellite dishes received the signals) and subscribers homes, numerous signal amplifiers were placed to boost the strength of the signal sent on the coax cable.

Starting in the early- to mid-1990's, the cable industry undertook the massive and expensive conversion of its traditional cable facilities into systems that (a) could support two-way transmission of signals (e.g., interactive video and video-on-demand systems), and (b) had a much higher capacity to support analog video signals, digital video signals, and data signals.

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<sup>39</sup> None of these applications require a huge upstream data path, and the applications could be likely supported with as little as 100 kbps of upstream bandwidth. Upstream bandwidth is more critical for companies or individuals who want to run a web or other type of server from their computer – something that is clearly *not* contemplated by most of the current broadband access vendors.

<sup>40</sup> Ironically, although many consider film movies to be of a higher quality than video, movies are shown with fewer frames per second than video, and thus movies can be stored and transmitted in less space, or at a lower bandwidth, than video. Of particular difficulty is live sports coverage, which often have many sudden movement that causes problems for video compression techniques.

These upgraded systems are commonly called “hybrid fiber-optic coax” – or “HFC” – cable systems. A fiber-optic cable (which carries signals with light instead of electricity) runs from the cable headend to “nodes” in residential communities. In addition to installing fiber trunks, cable companies also upgraded the coaxial cable running from the nodes to homes. Old amplifiers were removed and new two-way amplifiers were installed. But even with these upgrades, HFC cable systems are sensitive to electrical “noise” and other interference that can interfere with service.

A cable operator would likely upgrade its cable facility to an HFC system for reasons entirely independent of providing Internet services. An upgraded HFC plant can support significantly more cable channels, including both analog and digital channels. And HFC systems can give cable companies a competitive advantage in a market increasingly crowded with recent entries such as TV access through small satellite dishes.<sup>41</sup>

Once a cable system is upgraded to a two-way HFC system, cable operators can make further upgrades that will enable Internet access. Typically, the cable operator dedicates the bandwidth from a single cable channel for data delivery. The cable operator must then build a data network and install in each cable headend one or more (depending on the number of subscribers) “cable modem termination systems” (or “CMTS”), which directly support the sending and receiving of data over the cable system. In the subscriber’s home, a “cable modem” is installed in or attached to a personal computer, and it communicates with the CMTS back in the headend.

Coaxial cable and HFC cable systems can theoretically support speeds of more than 30 Mbps downstream. Speeds available to each Internet user, however, are significantly less than 30 Mbps for two reasons. First, cable modems themselves are frequently limited to speeds of 10 Mbps or less. Second and more importantly, the bandwidth supported by a CMTS is a *shared resource* that is shared by all Internet access customers served by a given CMTS. Thus, although cable modem service has significantly higher maximum speeds as compared to most DSL and other broadband services, users seldom in fact receive the top speed.

There is no clear and consistent answer as to the speed of cable modem service. Speed will differ between cable systems, and even within a cable system. One report based on testing at a single computer indicates that the cable modem speed varied from 160kbps to 1.3 Mbps.<sup>42</sup> Users report that cable modem service is often sluggish during peak afternoon and evening hours.<sup>43</sup>

A second concern that is more pressing with cable modem service than with other broadband options is security. In effect, a cable modem network is similar to a local area network

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<sup>41</sup> According to a definition offered by the cable industries leading trade association, the National Cable Television Association, HFC stands for a “network architecture developed by the cable industry which uses a blend of fiber and coaxial cable to bring consumers interactivity, greater channel capacity, increased signal strength, and improved reliability.” <[http://ncta.cyberserv.com/qs/user\\_pages/glossary.cfm](http://ncta.cyberserv.com/qs/user_pages/glossary.cfm)>. All of these features are valuable to a cable operator independent of the capability to support Internet access.

<sup>42</sup> “Speed Traps for Cable Modems?,” Washington Post (Apr. 14, 2000), at E01.

<sup>43</sup> *Id.*

that one would find in an office, which means that users have some ability to see (and possibly change or delete) files that are on another user's computer. There have been reports of users of cable modem systems being able to view files *on a neighbor's computer*.<sup>44</sup> These problems can generally be solved by installing software or hardware screens in each home, and increasingly cable service operators are addressing the issue.

Analysts and commentators note that, as of August 1999, over one million homes in North America subscribe to cable modem service.<sup>45</sup> At least 300,000 of those homes, however, are in Canada, where cable operators (compared to U.S. operators) (a) are far more complete in their deployment of upgraded HFC cable plants, and (b) have experienced a much higher percentage of installations per homes with access to the service. The Canadian experience may suggest coming trends for the U.S., or it may simply reflect the impact of Canada's significantly lower prices for cable modem service. Estimates suggest that the residential cable modem deployment in North America will grow to over four million by 2002.<sup>46</sup>

Cable systems pass (and thus are available to) approximately 90% of the homes in the U.S. The leading U.S. cable operators are forecasting that 90% of their systems will have been appropriately upgraded by the end of the year 2000, an estimate consistent with the experiences of Canadian operators. Although smaller cable operators may have less aggressive deployment goals, the forecasts suggest that by 2001, cable modem service will be an option for as many as 80% of U.S. homes.

### C. Broadband Over DSL

Digital Subscriber Line ("DSL") technology was developed in the late 1980's and was first widely used for non-Internet specific applications. DSL comes in a wide variety of forms, including ADSL, HDSL, IDSL, and SDSL, and is often generically referred to as "xDSL."<sup>47</sup> Each differing form of DSL has different characteristics and limitations. The form emerging as the primary DSL method for mass-market broadband Internet connections is ADSL, or Asymmetric DSL.

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<sup>44</sup> "Cable Modem Security: What you don't know . . .", PC World News Radio, Oct. 30, 1997, available at <<http://www.pcworld.com/news/daily/data/1097/971030164448.html>>. For a general overview of the cable modem security issue, see <<http://www.cable-modem.net/gc/security.html>>.

<sup>45</sup> Broadband Today, Staff Report to FCC Chairman William Kennard, October 1999, at 26, <<http://www.fcc.gov/Bureaus/Cable/Reports/broadbandtoday.pdf>>.

<sup>46</sup> *Id.* Cable modem subscribers on Time Warner cable systems alone rose from 186,000 as of June 30, 1999, to 447,000 as of March 31, 2000. Compare *id.* with "Time Warner Nears 500K Modem Sub. Mark," Broadband Daily, April 13, 2000, <[http://www.broadband-daily.com/subscribers/index.htm?article\\_id=1209](http://www.broadband-daily.com/subscribers/index.htm?article_id=1209)>.

<sup>47</sup> A good overview of DSL technology can be found at Robyn Aber, "xDSL Local Loop Access Technology: Delivering Broadband over Copper Wires," <[http://www.3com.com/technology/tech\\_net/white\\_papers/500624.html](http://www.3com.com/technology/tech_net/white_papers/500624.html)>. See also "General Introduction to Copper Access Technologies," [http://www.adsl.com/general\\_tutorial.html](http://www.adsl.com/general_tutorial.html).

The critical feature of ADSL (as well as all other DSL technology) is that existing copper wires used for traditional telephone service can also be used to provide high speed data services. In fact, with ADSL (though not with most other forms of DSL), the high-speed data connection can be run over *the same wire* that is used to carry a regular phone line. Thus, ADSL can share an existing wire with a user's existing voice telephone line, permitting both DSL and telephone services to be used at the same time.

ADSL is called asymmetric because its downstream speed (from the telephone company to the customer) is typically much faster than its upstream speed (back to the telephone company). Most other forms of DSL are symmetric – data travels at the same speed in both directions. ADSL is well suited for Internet access where the user commonly receives more information (from Web sites, etc.) than the user transmits.<sup>48</sup> ADSL can theoretically support downstream transmission speeds of up to 8 Mbps, but is most commonly available at speeds from 640 Kbps to 1.5 Mbps.<sup>49</sup>

With ADSL technology (as with most DSL services), there is a critical limitation on the distance of a customer's site from the telephone central office. With ADSL at speeds of 1.5 Mbps or less, the general distance limitation is about 18,000 feet, or somewhat more than 3 miles. Importantly, the limitation is on the length of the wire itself, and thus a home or business could well be less than 3 miles from a central office, but still be unable to get ADSL service because the wire – the local loop – is not run directly to the home or office.

This 18,000 foot limitation alone precludes over 20% of U.S. households from receiving ADSL service.<sup>50</sup> The number of candidate households is further somewhat reduced by the fact that DSL service cannot be offered on a line that has certain line conditioning equipment that telephone companies used to extend the capacity of lines.

Unlike cable modem service, ADSL service operates on dedicated wires that are unaffected by high usage by neighbors. Thus, theoretically, ADSL service will provide more reliable – but usually somewhat slower – Internet access than cable modem service. As with the Internet in general, however, there are other potential bottlenecks within a typical ADSL system that could slow down service. Specifically, all ADSL users' data packets must be transported from the telephone central office to the ISP's offices (before being sent on to the Internet).<sup>51</sup> If

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<sup>48</sup> The asymmetry of ADSL ultimately is a function of the interference that can arise when many symmetric electronic signals are sent over a large bundle of wires. Sending symmetric DSL signals would reduce the data rate on the lines. See "General Introduction to Copper Access Technologies," <[http://www.adsl.com/general\\_tutorial.html](http://www.adsl.com/general_tutorial.html)>.

<sup>49</sup> See *id.* The faster the speed of ADSL, the shorter the length of wire on which it can be supported.

<sup>50</sup> See *id.* Some business-oriented DSL services, such as IDSL, can be offered at distances greater than 18,000 feet, but at significantly lower speeds than ADSL. In addition, some companies are testing technology that has the potential to raise the 18,000-foot limit.

<sup>51</sup> Most of the incumbent local exchange carriers use an ATM network to transport data traffic from the central offices to the ISP. See <[http://www.xdsl.com/library/matrix\\_sheets/Service\\_071999.xls](http://www.xdsl.com/library/matrix_sheets/Service_071999.xls)>.

the data network between the central offices and an ISP is overcrowded, then ADSL service could face overload problems similar to those possible with cable modem service.

There are two primary types of DSL providers: “Incumbent local exchange carriers” (“ILECs”), such as Bell Atlantic, Bell South, and Southwestern Bell, historically have been the primary local telephone company in their regions. In competition with the ILECs are the “competitive local exchange carriers” (“CLECs”) such as Covad, NorthPoint, and Rhythms. These and other CLECs essentially owe their existence to the Telecommunications Act of 1996 that promoted local telephone competition by requiring the ILECs to sell discrete elements of the telephone network to competitive carriers.

Although DSL technology was developed by the early 1990’s, the ILECs did not aggressively market DSL until 1999.<sup>52</sup> Since then, the ILECs’ DSL products have been primarily marketed to residential Internet users. Common ILEC offerings have included 1.5 Mbps, 768 Kbps, or 640 Kbps in downstream (to the customer) data speed, with 90 Kbps or 384 Kbps in upstream (from the customer) speed. The ILECs’ DSL products are typically offered on a “best efforts” basis, meaning that no particular speed is guaranteed.<sup>53</sup> The ILECs typically price their DSL service in the \$50 to \$60 per month range.<sup>54</sup>

CLECs have focused more of their efforts on the business market.<sup>55</sup> The CLECs commonly have “best efforts” ADSL products that compete directly with the ILECs’ offerings. In addition, CLECs have other xDSL products that typically offer symmetrical, guaranteed-bandwidth service. CLECs typically price their DSL services in the \$70 to \$90 per month range for their consumer oriented products, and as much as \$300 to \$400 per month for their business oriented products.

As of the end of 1999, an estimated 500,000 DSL lines were deployed in the United States, with about 75% being ILEC lines and 25% being CLEC lines.<sup>56</sup> Deployment is projected to explode in the year 2000 (to over 2,000,000 DSL lines deployed), followed by significant growth in later years.<sup>57</sup> A number of leading ISPs have chosen to offer DSL services to their customers.<sup>58</sup>

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<sup>52</sup> Some assert that the ILECs did not want to erode their business market for T1 lines, and thus the ILECs were slow to push ADSL until cable companies started making serious in-roads into broadband.

<sup>53</sup> This is comparable to cable modem service, which is not typically offered on a guaranteed basis. Because of the lack of guarantees, neither cable modem service or consumer oriented DSL service is well suited to businesses that depend on Internet connectivity.

<sup>54</sup> For a matrix of prices and speeds of DSL offerings by ILECs, prepared by market strategy firm Telechoice, see <[http://www.xdsl.com/library/matrix\\_sheets/Service\\_071999.xls](http://www.xdsl.com/library/matrix_sheets/Service_071999.xls)>.

<sup>55</sup> For a comparison of the residential versus business deployment of ILECs and CLECs prepared by Telechoice, see <[http://www.xdsl.com/content/resources/deployment\\_info.asp](http://www.xdsl.com/content/resources/deployment_info.asp)>.

<sup>56</sup> See <[http://www.xdsl.com/content/resources/deployment\\_info.asp](http://www.xdsl.com/content/resources/deployment_info.asp)>. These deployment figures do not include the non-Internet-focused use of HDSL as a T1 substitute.

<sup>57</sup> See *id.*

<sup>58</sup> See “Bell Atlantic, Prodigy in DSL Deal,” *Broadband Daily*, May 25, 1999.

#### **D. Broadband Over Terrestrial Wireless**

Although significantly less established and deployed than cable and DSL broadband services, terrestrial wireless services using land-based transmitters can also provide broadband services to businesses and individuals. There are a number of different technological approaches to wireless broadband services, and it is far from clear which of these approaches will be successful in the marketplace. Nevertheless, it is likely that at least for some categories of users, broadband wireless will compete with cable and DSL services (as well as with traditional dedicated business-oriented high-speed T1 lines) to provide broadband access to the Internet.

Wireless broadband services are often called “fixed wireless” because the transmitting and receiving stations (of both the service provider *and* the customers) are in fixed, stationary positions. In other words, terrestrial or fixed wireless services are quite distinct from mobile cellular telephone service. Typically, a company offering fixed or terrestrial wireless services will operate one or more master microwave antennas installed on top of tall buildings or possibly mountains adjacent to populated areas. The users will rely on relatively small antennas on top of their office buildings or homes—some of which, because of their size and shape, are referred to as “pizza box” antennas. In the implementations most likely to compete with cable and DSL services, users’ antennas act as both receivers of downstream Internet data and transmitters of upstream data.

As with DSL technology, transmitting data by microwave or other wireless signals is not a new idea,<sup>59</sup> but only recently has it been available to broad groups of Internet users. Two critical factors boosted the potential of wireless broadband services. First, the cost of equipment declined significantly over the past ten years. Second, the Federal Communications Commission made more radio spectrum available for used by data service providers. For example, in 1998 the FCC changed its rules to allow certain spectrum that had been used for one-way video transmission to be used instead for two-way data transmission.<sup>60</sup> This change alone led directly to the commercial feasibility of MMDS wireless service discussed below.<sup>61</sup>

The two leading types of wireless services that can support broadband access to the Internet are “Local Multipoint Distribution Service” (“LMDS”) and “Multichannel Multipoint Distribution Service” (“MMDS”). LMDS and MMDS generally both require a “line of sight” between a central antenna and a customer’s antenna. LMDS provides faster speeds than MMDS, but can only support customers within two or three miles of a central antenna. LMDS is therefore best suited for businesses located in dense urban areas. LMDS is, however, susceptible

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<sup>59</sup> Indeed, one part of MCI WorldCom, a prime contender in today’s marketplace for wireless broadband services, was originally named “Microwave Communications, Inc.” before its name was changed to MCI, Inc.

<sup>60</sup> See Report & Order, In the Matter of Amendment of Parts 21 and 74 to Enable Multipoint Distribution Service and Instructional Television Fixed Service Licensees to Engage in Fixed Two-Way Transmissions, MM Docket No. 97-217 (Sept. 25, 1998), <[http://www.fcc.gov/Bureaus/Mass\\_Media/Orders/1998/fcc98231.pdf](http://www.fcc.gov/Bureaus/Mass_Media/Orders/1998/fcc98231.pdf)>.

<sup>61</sup> WorldCom, a leading MMDS provider, directly credits the 1998 FCC decision with making MMDS a more viable offering. “Interpreting the Changing MMDS Landscape,” WorldCom, Inc., at 11, <[http://www.wcom.com/about\\_the\\_company/mmids\\_landscape/mmids\\_briefbook.pdf](http://www.wcom.com/about_the_company/mmids_landscape/mmids_briefbook.pdf)>.

to interference from rain and snow. Service providers such as Winstar and Teligent are using LMDS to target businesses.

In contrast, MMDS technology cannot support such high speeds, but it can reach customers who are located much farther from an antenna than would be possible using an LMDS system. Technically, MMDS' zone of coverage could extend 35 miles in every direction from a central tower (covering over 3500 square miles compared to less than 50 square miles covered by a single LMDS station). MMDS can be deployed more cheaply and can reach more efficiently into suburban and rural areas. Both WorldCom and Sprint have invested heavily in MMDS technology.

LMDS, MMDS, and other approaches (such as the Wireless Local Loop being tested by AT&T), however, all still require a line-of-sight, or near-line-of-sight, path between master and customer locations. As a result, buildings, trees, and other impediments can prevent wireless technology from serving many potential customers in an area. Because of this limitation, many leading providers (like AT&T and MCI WorldCom) are likely to use wireless technology to fill in gaps in their DSL or cable coverage. On the whole, wireless technology will probably be an important aspect of widespread broadband availability, but it is unlikely that wireless will ever become a ubiquitous option for all consumers.

## **E. Broadband Over Other Technologies**

Beyond cable, DSL, and terrestrial wireless services, other broadband access methods are still in development and/or testing, and none are certain to become technologically and commercially viable. Many companies—both startups and well-established market participants—are investing substantial money to develop and deploy new forms of broadband access to the Internet. It will likely be 2001 or 2002 before it becomes clearer whether these ventures will succeed.

**Satellite Access:** Most often grouped with cable, DSL, and wireless, satellites access technology will use satellites to deliver Internet access to homes and businesses.

Today, one can receive high speed Internet service from Hughes Network Systems, but its DirecPC product is a *one-way* service. DirecPC uses a satellite to deliver content to customers but requires that customers transmit content requests to an ordinary ISP over a standard dial-up phone line. This approach is often called a “telco return” because it relies on a standard telephone connection for any transmissions from Internet users.<sup>62</sup> Because one-way service requires the use of a phone line and an ISP, and because it lacks the “always on” characteristic of other broadband services, it is not viewed as a long-term broadband solution. DirecPC has announced that it hopes

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<sup>62</sup> For a helpful explanation of how a “telco return” system works, see “How does it work?,” <<http://www.direcpc.com/consumer/work/work.html>>.

to begin offering *two-way* satellite Internet access by early 2001.<sup>63</sup> That service will, however, generally be slower than most cable, DSL, and terrestrial wireless offerings; Hughes anticipates replacing the service by 2003 with an “advanced generation” of service on its “Spaceway satellite platform.”<sup>64</sup>

In addition to Hughes, a number of other companies hope to deliver two-way broadband access services by satellite. For example, iSKY plans to offer 1.5 Mbps (downstream) service via satellite (with 500 Kbps upstream) before the end of 2001.<sup>65</sup> Teledesic, which announced its plans to offer broadband satellite service in 1994, hopes to be operational by 2004.<sup>66</sup> These services suffer from the uncertainties of whether the technology will work in practice and whether cable, DSL, and wireless will have won key parts of the market before the satellites become fully operational.<sup>67</sup> In the wake of the bankruptcy of the Iridium satellite-based telephone system, investors and analysts are skeptical of whether Teledesic (and other satellite Internet services) will succeed.<sup>68</sup>

**Fiber-to-the-home:** Another broadband alternative is fiber optic lines running directly into users’ homes and businesses. Although fiber does not share the same technological uncertainties facing satellite systems, it is not clear whether it will be economically viable to run fiber optic wires through existing residential neighborhoods. ILEC BellSouth is the most significant market participant to test “fiber-to-the-home.” BellSouth began in 1999 to run fiber to a limited number of homes in Dunwoody, Georgia (an affluent suburb of Atlanta) in a permanent installation of the technology. BellSouth plans to offer both Internet access and video services over the fiber. Futureways is preparing to offer fiber optic services on a large scale in five suburbs of Toronto, Canada. Some U.S. cities, such as Palo Alto, California and Concord, Massachusetts, are experimenting with municipally supported fiber installations.<sup>69</sup>

Fiber optic cables can support an extraordinarily high bandwidth of Internet traffic – possibly reaching 1000 Mbps, compared to 1.5 Mbps for typical cable and DSL offerings. In practice, fiber installations will offer 100 Mbps to individual users. The downside, however, is the cost of install the fiber optics – even in brand new neighborhoods, fiber costs at least 15 percent more than ordinary copper wire. Still, BellSouth and others appear willing to install fiber

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<sup>63</sup> See Washington Internet Daily, Sept. 22, 2000, at 6; “Hughes Network Systems Announces Upcoming Two-Way DirecPC Satellite Internet Access,” Apr. 27, 2000, <[http://www.hns.com/news/pressrel/csp\\_pres/p042700.htm](http://www.hns.com/news/pressrel/csp_pres/p042700.htm)>.

<sup>64</sup> “Hughes Network Systems Announces Upcoming Two-Way DirecPC Satellite Internet Access,” Apr. 27, 2000, <[http://www.hns.com/news/pressrel/csp\\_pres/p042700.htm](http://www.hns.com/news/pressrel/csp_pres/p042700.htm)>.

<sup>65</sup> See “Answers to frequently asked questions,” <<http://isky.net/qa/face.html>>.

<sup>66</sup> See “Bruised Teledesic at Brink: Tech Firm’s ‘Net-in-sky’ plan depends on new investors, secret recovery strategy,” USA Today, Apr. 11, 2000, <<http://www.usatoday.com/life/cyber/invest/in567.htm>>.

<sup>67</sup> *Id.*

<sup>68</sup> *Id.*

<sup>69</sup> The current state of “fiber to the home” technology and deployment is discussed at length in “Fiber Optics to the Home,” Technology Review, March/April 2000, <<http://www.techreview.com/articles/ma00/hecht.htm>>.

in some new areas. In existing neighborhoods, where copper wire has already been laid, however, the cost of running fiber into homes may well be prohibitive in the near term.<sup>70</sup>

To date, no company has announced any plans to install fiber-to-the-home into existing residential neighborhoods on any wide scale. Although fiber-to-the-home may be economical in the future, it is not presently a clearly viable alternative.

**Broadband over power lines:** Both cable modem and DSL offerings seek to capitalize on existing “pipes” or wires, into the home. The only remaining wire into most homes is the electric utility wire. A number of schemes to use power lines to transport Internet access services have been explored over the past few years, but none have yielded a marketable service offering. The leading test of powerline service offerings encountered significant technical difficulties and ultimately was abandoned.<sup>71</sup>

Two companies, Oneline AG in Europe and Media Fusion in Texas, have announced that they are currently testing or developing powerline based products.<sup>72</sup> If the services work as hoped, utility companies could well become major players in the broadband access market. It is far from clear, however, when, or if, powerline services will become feasible.

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<sup>70</sup> See *id.* (discussing these and other issues).

<sup>71</sup> “British Net project loses power,” CNET News, May 29, 1998, <<http://cnet.com/news/0-1004-200-329713.html>>.

<sup>72</sup> See “Internet access over power lines nears reality,” CNET News, March 6, 2000, <<http://cnet.com/news/0-1004-202-1564871.html>>.